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SILVICAL CHARACTERISTICS of YELLOW BUCKEYE

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*Ohio buckeye
*Yellow buckeye
*Northern red oak
*Black oak
*Chinkapin oak
*Pin oak
*White oak
*Swamp white oak
*Bur oak
*Butternut
*Black walnut
*Shellbark hickory
*Sycamore
*Honeylocust
Hackberry
Black locust
*Eastern redcedar

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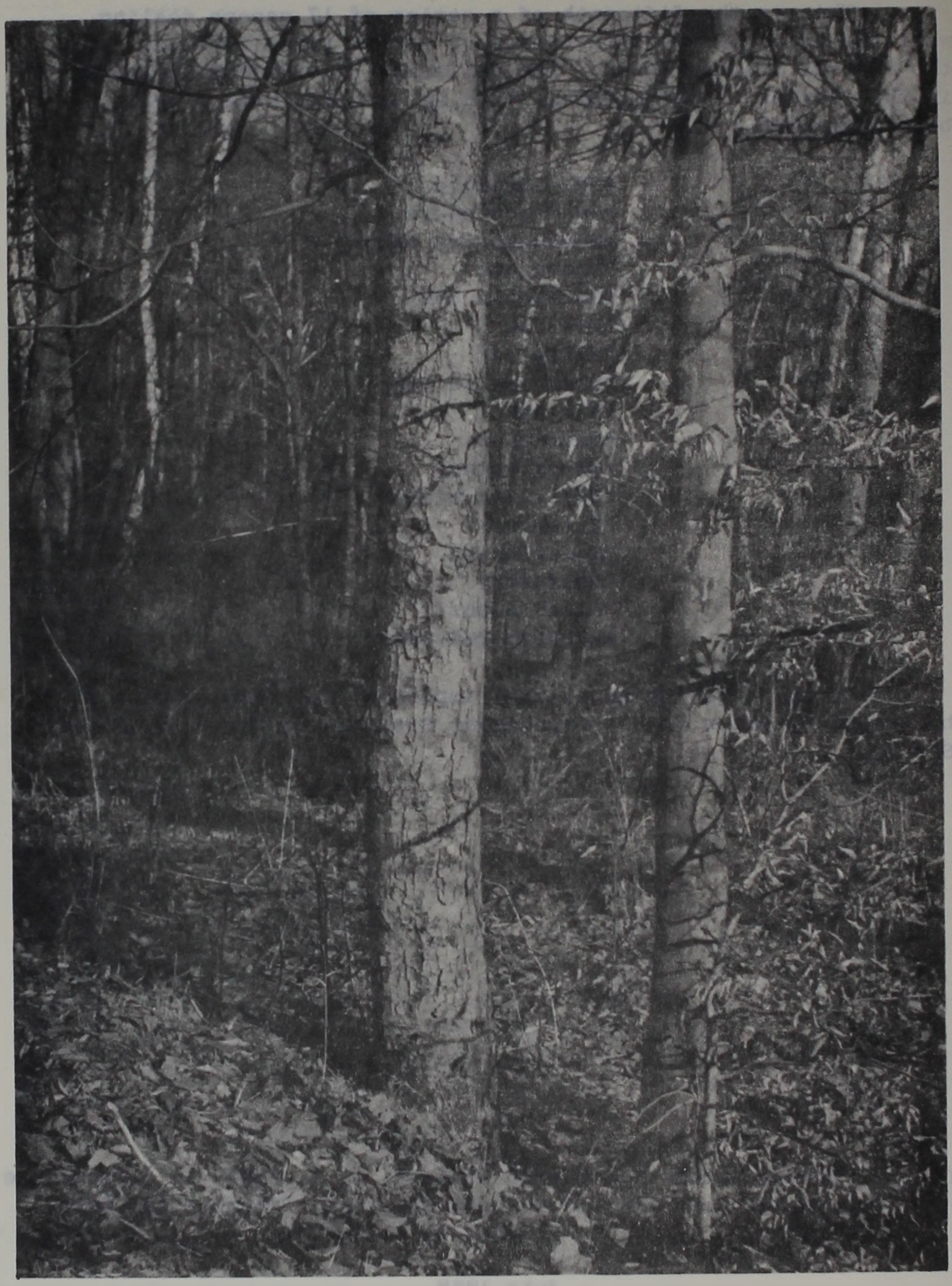

Silvical Characteristics of Yellow Buckeye

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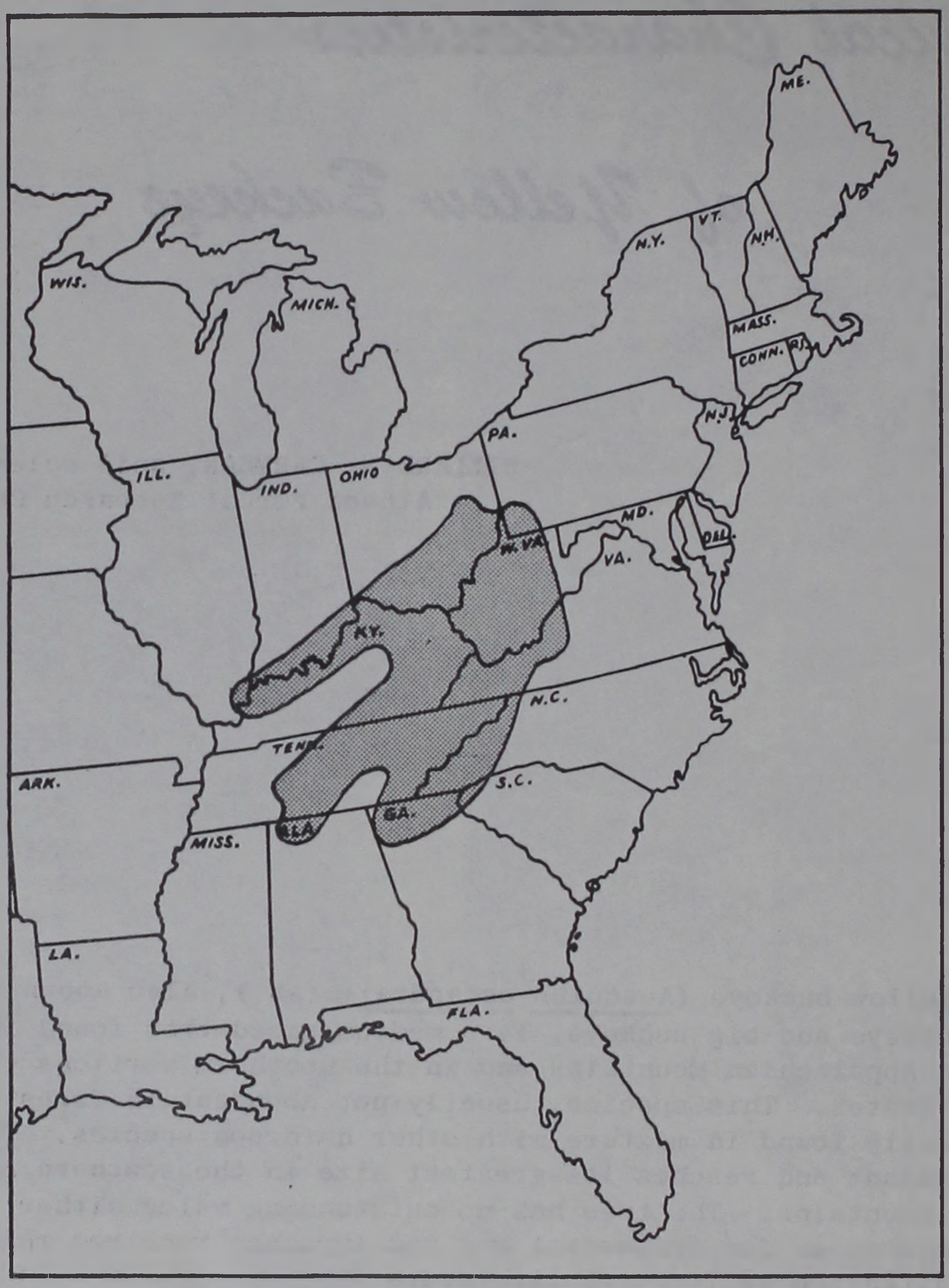
Yellow buckeye (Aesculus octandra Marsh.), also known as sweet buckeye and big buckeye, is a medium-sized tree found in the southern Appalachian Mountains and in the southern portions of the Central States. This species, usually not abundant in forest stands, is generally found in mixture with other hardwood species. It is most abundant and reaches its greatest size in the southern Appalachian Mountains. The tree has no outstanding value either for wood products or for ornamental use and thus has received relatively little attention in forestry literature.

The name, buckeye, is the literal translation of the Indian work "hetuck" meaning "eye of the buck". The large round pale scar on the seed was thought to resemble the eye of the buck deer and Indians used the name as a word of admiration for individuals held in high esteem. Buckeye became associated with Ohio during the presidential campaign of 1840 when Ohioans identified themselves and their political preferences by carrying buckeye canes and wore buckeye seeds either as campaign buttons or as strings of beads (14, 18, 35).

1/ Numbers in parentheses refer to Literature Cited, p.12.

DISTRIBUTION (5, 7, 8, 13, 24, 25, 28, 36)



HABITAT CONDITIONS

Climate

Yellow buckeye grows in a wide range of climates, varying from that of the Appalachian Mountains to that of the Central States. Average annual precipitation ranges from 84 inches per year in local areas of the mountains of western North Carolina to as low as 38 inches in southern Ohio, Indiana, and Illinois. The average annual snowfall is as great as 40 inches in the mountains and may be less than 5 inches in the southern part of the range. Average annual temperature is 50° F. in southwestern Pennsylvania and 60° F. in northern Georgia; average annual minimum temperatures are no lower than 0° F. and average annual maximum temperatures do not exceed 100° F. The number of frost-free days varies from 150 days in the mountains of West Virginia to 210 days in northern Alabama and Georgia (40).

Soils and Physiography

Betts (3) reports that yellow buckeye grows best in rich, moist soil found in river bottoms and along the banks of streams. Harlow and Harrar (25) state that best development is on deep fertile soils in the mountains of North Carolina and Tennessee. They report that yellow buckeye is a bottomland species in the northern part of its range, but further south, it is found on high, mountainous slopes. Braun (6), in listing the stand composition of several mixed mesophytic forest stands of the Appalachian and Cumberland Mountains, shows that yellow buckeye is largest and most numerous in coves and on northern slopes and that it generally occurs in areas having deep dark soil with a good crumb, mull humus.

Braun also observes that yellow buckeye is abundant in the mixed mesophytic forest almost to the boundary of Wisconsin glaciation (6, 7). It occurs locally within the area of Illinoian glaciation in Ohio and Indiana but is seldom found within the area of Wisconsin glaciation. Braun further states that this relationship to the boundary of Wisconsin glaciation should not be considered as evidence that a climatic limit has been reached in the north or that the range limit of yellow buckeye is at a soil boundary. Hardin considers buckeye as a climax species whose range was abruptly terminated during Pleistocene glaciation. It has made very little progress in re-extending its range northward and must await the slow changes of forest environment before northward migration can occur (24).

Associated Species

Braun lists yellow buckeye as an important member of the mixed mesophytic forest association in the southern Appalachian Mountains and in the Cumberland Palteau Region (6). Although this association has a large number of dominant species, yellow buckeye, and white basswood are usually constant members of the association. Yellow buckeye composed 16 to 23 percent of the canopy trees in the mixed mesophytic stands listed by Braun.

Cain (10) and Whittaker (43) have described the occurrence of yellow buckeye in the Great Smoky Mountains of North Carolina and Tennessee. Descriptions by Whittaker indicate that the greatest concentration of buckeye is in mesic coves, canyons, and ravines. The tree is commonly found at elevations from 1,500 to 6,100 feet with the greatest numbers occurring between 4,000 and 5,000 feet. Forest types in which buckeye is most common are similar to the mixed mesophytic forests described by Braun.

Braun describes an "association-segregate" of the mixed mesophytic forest that occurs in the higher Cumberland Mountains in an altitudinal band "extending from about 1,500 or 2,000 feet in elevation upward for about 1,000 feet or more" (6). This segregate is described as the "sugar maple - basswood - buckeye forest". Yellow buckeye may comprise from 15 to 30 percent of the canopy trees in this segregate. Braun speaks of this forest as follows:

> ". . .one of the most magnificant communities of the whole mixed mesophytic forest. Its trees are large (mostly three to four feet, d.b.h.) with towering columnar trunks, often rather widely spaced. Its herbaceous layer is exceedingly luxuriant, with large ferns and a wealth of spring flowers, among which Trillium grandiflorum, T. erectum (red, white and yellow forms), Delphinium tricorne, Phacelia bipinatifida, Uvularia grandiflora (organge-yellow), and Disporum maculatum are perhaps most showy. The last named is here limited to this community. The soil is deep and dark, with good crumb mull humus."

The author continues:

> "In the outlying section of the Cumberland Mountains and in other sections of the Mixed Mesophytic Forest Region, this association-segregate developes only locally, usually on north slopes, and with no relation to altitude. Closely related forest communities occur in the cove and ravine forests of the Great Smoky Mountains, there complicated by the addition of silverbell tree (Halesia monticola) black cherry, and, sometimes, hemlock."

She shows that west of the Appalachians and in the Central States the mixed mesophytic forest is local in occurrence and is usually confined to such habitats as coves, ravines, and bottoms.

Braun's stand descriptions of the Appalachian Mountains and the Central States show that, although reduced in numbers, yellow buckeye does occur in forest communities other than the mixed mesophytic. Yellow buckeye apparently extends upward into the "sugar maple - beech - yellow birch" community and may even occasionally be found in the "red spruce - Fraser fir" community of the higher Appalachian Mountains. The tree is sometimes found at low elevations in favorable areas of the "beech-maple" community of the Appalachians and Central States. In Alabama and in the Illinois Ozarks, yellow buckeye is uncommon and usually occurs as a low shrub.

Yellow buckeye is listed as a minor associate of six forest cover types by the Society of American Foresters (37). The tree is mentioned only in connection with its occurrence in the southern Appalachians. These six cover types include sugar maple - beech - yellow birch, black cherry, red spruce - yellow birch, red spruce, red spruce - Fraser fir, and northern red oak - basswood - white ash.

Except for Braun's descriptions, listed above, the relation between indicator plants and the growth or occurrence of yellow buckeye has not been studied. The soil and topographic conditions where yellow buckeye is found is generally excellent for the growth of yellow poplar, white ash, and various oaks. Many of the herbaceous indicator plants described by Trimble and Weitzman (39) for excellent oak sites in West Virginia might also occur in stands containing yellow buckeye.

LIFE HISTORY

Seeding Habits

The yellow or yellowish-white (rarely red, pink, or cream-colored) flowers of yellow buckeye appear in the early spring when the leaves are about half grown. The flowers are about 1 to 1 1/2 inches long and are borne in clusters (terminal thyrse or dense terminal panicle) that vary from 5 to 7 inches in length (15, 34). Small glands are found on the flower pedicels--a characteristic only of yellow buckeye (22, 23, 24). The flowers on a single inflorescence are both staminate and perfect. However, most flowers are imperfect and the majority of mature seed capsules are produced from the few perfect flowers located at the periphery of the inflorescence (21).

The fruit of yellow buckeye is a rounded leathery pod or capsule that is 2 to 3 inches in length. The capsule is rather smooth, unlike the spiny capsule of the Ohio buckeye. Hardin (20) reports that more than half the capsules of yellow buckeye are 1-seeded, although 2-, 3-, and 4-seeded forms are found in decreasing frequencies. Hardin states that the fruit of buckeye is potentially 6-seeded because the ovary is 3-locular with two ovules in each locule. He believes variation in seed number may be due to aborted ovules caused by incomplete fertilization.

The seed of yellow buckeye is large and rounded with a thick, shiny, chocolate-colored coat. It has a large, round, pale scar that resembles the pupil of an eye. Seeds are flattened or angular if two or more seeds are produced in a single capsule. Yellow buckeye seed does not contain an endosperm; the cotyledons are very thick and fleshy and remain underground in germination (15, 41). The seed ripens and is dispersed in September. Dispersal is by gravity, animals, and sometimes by water (41).

The number of cleaned seed per pound varies between 27 and 30 and purity and soundness are about 100 percent (41). Following collection the seed should not be exposed to excessive drying or a loss in viability may result. Seed should be sown at once or should be stratified and sown in the spring. Data on optimum storage conditions are lacking. However, it is believed that greater viability is retained if the seeds are kept in sealed containers at temperatures slightly less than 32° F. so as to prevent drying (41).

No information is available concerning tree age at which seed bearing begins. Information is also lacking concerning the number of seeds produced by individual trees, the conditions favoring seed production, and the frequency of seed years.

Vegetative Reproduction

No reports are available concerning the sprouting ability of yellow buckeye. However, as with most hardwoods, sprouting is probably more vigorous when trees are cut at a young age. Trees that have apparently originated from sprouts have been observed in southeastern Ohio. It has been reported that buckeye can be propagated by grafting and budding (41).

Seedling Development

Germination occurs in early spring after the seeds have lain on the ground during the winter. Although germination is delayed due to embryo dormancy, this may be overcome by stratifying in moist sand at 41° F. for about 120 days. Germinative capacity is variable but is reported to average 70 percent (41).

Yellow buckeye develops a large taproot following germination (41). Copeland (11) used the seed of California buckeye to study geotropism because this species also develops a large taproot. He found that the cotyledons serve solely as food-storage organs and that they remain in or on the ground during germination. Copeland also described the development of the hypocotyl and plumule of California buckeye during germination. It is possible that germination and early growth of yellow buckeye is similar to that of California buckeye.

No reports are available concerning germination and early growth and survival of yellow buckeye under natural conditions. The natural occurrence of the tree, however, indicates that moist, deep soils are favorable for the germination and survival of seeds and seedlings. Although no studies have been made, it is probable that adequate reproduction does not occur at great distances from seed trees because the seed is large and heavy. Removal of large numbers of seed from the area around the seed tree is unlikely because the poisonous seed is not used for food by animals.

Sapling Stage to Maturity

Growth Rate and Yield

Yellow buckeye is one of the first trees to leaf out and begin shoot growth in the spring. General observation in the forest indicates that it has an intermediate growth rate. In forest conditions it attains large size and has a long, clean trunk (6). It is the largest of all native buckeyes and the largest tree reported occurs in the Great Smoky Mountains National Park (2). This tree has a circumference of 15 feet, 11 inches, a height of 85 feet, and a spread of 54 feet. A yellow buckeye with a circumference of 14 feet, 8 inches is growing in Washington County, Ohio (17).

Yellow buckeye is apparently rather sensitive to soil and topographic conditions that affect growth rates because the larger trees generally occur in coves, ravines, or on north slopes where site quality is generally excellent. Yellow buckeye is probably

long-lived because it reaches large size and maintains an important position in the mixed mesophytic forest "climax" reported by Braun (6).

Reaction to Competition

The ability of yellow buckeye to maintain its position as a member of the mixed mesophytic forest "climax" indicates that the tree is rather tolerant of competition for light and soil moisture when growing in favorable soil and topographic conditions. To maintain such a "climax" position the tree must be capable of germinating, surviving, and growing, when subjected to the competition of a closed mixed mesophytic forest stand. The local occurrence and limited number of yellow buckeye are probably related to limited seed dissemination and to the inability of the species to successfully compete with other tree species except in areas having favorable soil and moisture conditions. The critical period of competition may be during germination and in the early life of the seedling.

Climax Position

Yellow buckeye is not a pioneer species and is seldom found on old fields or on other open land. Seed dissemination is probably limited because the seed is so heavy and unpalatable. The rapid loss of seed viability when exposed to drying may limit germination of seed on dry exposed sites. In addition, it is possible that seedlings and saplings suffer severely from prolonged moisture deficits in dry areas.

As discussed previously, yellow buckeye is an important component of the mixed mesophytic forest "climax" (6) and it occurs as a consistent, although minor, associate of six forest cover types listed by the Society of American Foresters (37). All of these types, except black cherry, are "climax" or "near-climax" in successional position. Forest types in which yellow buckeye is found are in coves, ravines, and on north slopes and these forest types might be classified as "edaphic" or "physiographic climaxes".

ENEMIES AND HAZARDS

Insects

No major insect enemies of yellow buckeye are known that consistently cause severe defoliation or that damage the woody parts of the tree. A buckeye lacebug (*Corythucha aesculi*) has been reported

as feeding on the foliage of various species of buckeye (12). Stehr (38) reports that yellow buckeye in southeastern Ohio is frequently infested by this lacebug. Leaves are damaged by the oviposition of eggs; stomata are blocked by multitudinous flecks of fecal matter; and nymphs feed on the leaves. Foliage on young buckeye trees and lower branches of older trees is attacked early in the spring because yellow buckeye is one of the first trees in southeastern Ohio to leaf out. By the middle of July, leaves turn yellowish or brown and many young trees are nearly defoliated. Stehr believes this injury is not severe enough to kill the trees but is probably sufficient to retard growth.

Yellow buckeye is occasionally attacked by the English walnut scale (Aspidiotus juglans - regiae) and the white marked tussock moth (Heterocampa leveostigma) (27). The oyster shell bark louse (Lepidosaphes ulmi) also causes some defoliation (27, 31).

Diseases

Yellow buckeye is relatively free of diseases. Leaf-blotch (Guignardia aesculi) is the most destructive disease affecting the buckeyes and horsechestnut (4, 32). Rainy seasons are especially favorable for the germination of the spores of this disease. When trees are severely affected, the foliage from a distance appears to have been scorched by fire and the disease may cause much defoliation. Repeated defoliation may retard the growth of the trees.

A powdery mildew (Uncinula flexuosa) attacks the leaves of buckeye (4, 32). A leaf spot (Cercospora aesculina) and other localized diseases of buckeye have been reported (1). Yellow buckeye is relatively free of defect caused by the wood-rotting fungi that attack the heartwood of many deciduous trees. However a white spongy sapwood rot caused by Collybia velutipes, a hairy-stemmed toadstool which often occurs in clusters in wounds, causes some damage (4).

Birds and Animals

The abundant large nuts of yellow buckeye contain much starch but are apparently not suitable for food. Fernald and Kinsey (16) and Muenscher (29) report that the buckeyes contain a poisonous glucoside known as aesculin. These authors state that the American Indians roasted the nuts among hot stones, thus

loosening the shells. The nuts were then peeled, mashed, and leached with water for several days. This treatment apparently removed the aesculin and resulted in a wholesome and highly nutritious food.

Book binders prefer a paste made of the starch of buckeye seed because this paste is not eaten by insects that attack books (30). Young shoots and seed of buckeye are reported to be poisonous to livestock (13, 30, 42) and some landowners in Indiana have exterminated buckeye for this reason. Red buckeye is reported to have been used in the capture of fish (16). "The powdered seeds seeds and bruised branches, if thrown into small ponds and stirred awhile, will so intoxicate fish that they rise to the surface and may be taken by hand." Other species of buckeye may also produce this effect because of aesculin in the seeds and young shoots.

Because the seed of yellow buckeye is poisonous it seems probable that the use of seeds for food by animals is not a limiting factor in the reproduction of this species.

RACES AND HYBRIDS

Two varieties of yellow buckeye are listed by Rehder (33) and are described by Hardin (24):

Aesculus octandra var. *virginica* - a red-flowered form in West Virginia

Aesculus octandra var. *vestita* - densely tomentose leaves and branches

An early investigation by Hoar (26) showed that the buckeyes frequently had chromosome irregularity and that pollen was often morphologically sterile. Hoar considered this as evidence of hybridization among the various buckeyes. A recent study of hybridization among the buckeyes has been completed by Hardin who states (22): "Since introgression is widespread in the populations of eastern United States, it is rare that a specimen taken from a wild population is exactly intermediate between two species, i.e., the F_1 hybrid. Hybrids are more likely to represent backcrosses or various other recombinants." Hardin also states "...northward and westward in glaciated areas where *A. octandra* does not exist, there has been a widespread infiltration of some germplasm of *A. octandra* into the populations of *A. Glabra*."

Hardin has recently completed a revision of the American buckeye family (23, 24). The following hybrids of yellow buckeye are recognized by Hardin (22):

Aesculus x hybrida (A. octandra x A. pavia)
Aesculus x marylandica (A. glabra x A. octandra)
Aesculus x arnoldiana (A. glabra x A. hybrida)
Aesculus x glaucescens (A. octandra x A. sylvatica)
Aesculus octandra x (A. pavia x A. sylvatica)

SPECIAL FEATURES

The bark of older yellow buckeye trees is about 3/4 inch thick, gray (dark brown when young), divided by shallow fissures, and separated on the surface into large scaly plates (24, 34). The bark is lighter in color and more shaggy in appearance than that of Ohio buckeye, and the bruised foliage and twigs of yellow buckeye do not have as disagreeable an odor as does Ohio buckeye (25). This latter characteristic may account for the name "sweet" buckeye commonly given to yellow buckeye. The fruit capsule is smooth and not spiny as with Ohio buckeye and the 5-7 leaflets of yellow buckeye are somewhat larger and broader than those of Ohio buckeye.

The wood of yellow buckeye is light, soft, weak in bending and endwise compression, low in shock resistance and durability. It is used for boxes, crates, containers, artificial limbs, woodenware and novelties, and furniture (9). Early settlers are reported to have used buckeye troughs for the collection of sap from tapped maple trees (19). In general, buckeye is not greatly valued in the lumberyard (30); however, quality of buckeye lumber in western North Carolina was found by the Southeastern Forest Experiment Station to be comparable to that of white and black oak.

TREE SPECIES MENTIONED

White ash	-	Fraxinus americana L.
White basswood	-	Tilia heterophylla Vent.
American beech	-	Fagus grandifolia Ehrh.
Yellow birch	-	Betula alleghaniensis Britton
California buckeye	-	Aesculus californica (Spach) Nutt.
Ohio buckeye	-	A. glabra Willd.
Painted buckeye	-	A. sylvatica Bartr.
Red buckeye	-	A. pavia L.
Yellow buckeye	-	A. octandra Marsh.
Black cherry	-	Prunus serotina Ehrh.
Fraser fir	-	Abies fraseri (Pursh) Poir.
Eastern hemlock	-	Tsuga canadensis (L.) Carr.
Horsechestnut	-	Aesculus hippocastanum L.
Sugar maple	-	Acer saccharum Marsh.
Black oak	-	Quercus velutina Lam.
Northern red oak	-	Q. rubra L.
White oak	-	Q. alba L.
Mountain silverbell	-	Halesia carolina var. monticola Rehd.
Red spruce	-	Picea rubens Sarg.
Yellow-poplar	-	Liriodendron tulipifera L.

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